NAVAL POSTGRADUATE SCHOOL
Monterey, California

THESIS

COAST GUARD COASTAL PATROL BOAT
COMMUNICATIONS DEMAND:
AN ECONOMIC APPROACH

by

Curtis A. Stock

June, 1991

Thesis Advisor: William R. Gates

SECURITY CLASSIFICATION OF THIS PAGE

REPORT DOCUMENTATION PAGE

Form Approved OMB No 0704-0188

1a REPORT SECURITY CLASSIFICATION UNCLASSIFIED	1b RESTRICTIVE MARKINGS
2a SECURITY CLASSIFICATION AUTHORITY	3 DISTRIBUTION/AVAILABILITY OF REPORT Approved for public release; distribution is unlimited
2b DECLASSIFICATION/DOWNGRADING SCHEDULE	
4 PERFORMING ORGANIZATION REPORT NUMBER(S)	5 MONITORING ORGANIZATION REPORT NUMBER(S)
6a NAME OF PERFORMING ORGANIZATION Naval Postgraduate School 6b OFFICE SYMBOL (If applicable) AS	7a NAME OF MONITORING ORGANIZATION Naval Postgraduate School
6c. ADDRESS (City, State, and ZIP Code) Monterey, CA 93943-5000	7b ADDRESS (City, State, and ZIP Code) Monterey, CA 93943-5000
8a NAME OF FUNDING/SPONSORING ORGANIZATION 8b OFFICE SYMBOL (If applicable)	9 PROCUREMENT INSTRUMENT IDENTIFICATION NUMBER
8c ADDRESS (City, State, and ZIP Code)	10 SOURCE OF FUNDING NUMBERS PROGRAM ELEMENT NO / PROJECT NO / TASK NO / WORK UNIT ACCESSION NO

11 TITLE (Include Security Classification) COAST GUARD COASTAL PATROL BOAT COMMUNICATIONS DEMAND: AN ECONOMIC APPROACH

12 PERSONAL AUTHOR(S)
STOCK, Curtis A.

13a TYPE OF REPORT	13b TIME COVERED	14 DATE OF REPORT (Year, Month, Day)	15 PAGE COUNT
Master' Thesis	FROM ____ TO ____	1991 June	78

16 SUPPLEMENTARY NOTATION The views expressed in this thesis are those of the author and do not reflect the official policy or position of the Department of Defense or the US Government.

17 COSATI CODES			18 SUBJECT TERMS (Continue on reverse if necessary and identify by block number)
FIELD	GROUP	SUB-GROUP	demand; marginal cost; marginal benefit; demand forecasting; Coast Guard Coastal Patrol Boat

19 ABSTRACT (Continue on reverse if necessary and identify by block number)

The Coast Guard is examining the requirements for a new Coastal Patrol Boat to replace the aging POINT class patrol boat. The communications capabilities of the new vessel class is of particular interest to its designers.

The purpose of this thesis is to analyze the ship/shore data communications need as perceived by the operators. The theoretical framework of the study is based on economic theory and demand forecasting. Communications needs are estimated through a survey of operators both afloat and ashore with experience in the present POINT class patrol boat. Several implementation considerations are presented which, although not directly affecting the communications requirements, are important factors to the survey respondents. Three levels of service, or tiers, are then offered to meet the ship/shore communications needs identified in this study.

20 DISTRIBUTION/AVAILABILITY OF ABSTRACT ☒ UNCLASSIFIED/UNLIMITED ☐ SAME AS RPT ☐ DTIC USERS	21 ABSTRACT SECURITY CLASSIFICATION UNCLASSIFIED
22a NAME OF RESPONSIBLE INDIVIDUAL William R. Gates	22b TELEPHONE (Include Area Code) (408) 646-2754 22c OFFICE SYMBOL AS/Gt

DD Form 1473, JUN 86 Previous editions are obsolete. SECURITY CLASSIFICATION OF THIS PAGE

S/N 0102-LF-014-6603

Approved for public release; distribution is unlimited.

Coast Guard Coastal Patrol Boat
Communications Demand: An Economic Approach

by

Curtis A. Stock
Lieutenant, United States Coast Guard
B.S., United States Coast Guard Academy, 1980
M.S., University of Washington, 1986

Submitted in partial fulfillment
of the requirements for the degree of

MASTER OF SCIENCE IN TELECOMMUNICATIONS SYSTEMS MANAGEMENT

from the

NAVAL POSTGRADUATE SCHOOL
June 1991

Author: Curtis A. Stock

Curtis A. Stock

Approved by: William R. Gates

William R. Gates, Thesis Advisor

Myung Suh

Myung W. Suh, Second Reader

David R. Whipple, Chairman
Department of Administrative Sciences

ABSTRACT

The Coast Guard is examining the requirements for a new Coastal Patrol Boat to replace the aging POINT class patrol boat. The communications capabilities of the new vessel class is of particular interest to its designers.

The purpose of this thesis is to analyze the ship/shore data communications need as perceived by the operators. The theoretical framework of the study is based on economic theory and demand forecasting. Communications needs are estimated through a survey of operators both afloat and ashore with experience in the present POINT class patrol boat. Several implementation considerations are presented which, although not directly affecting the communications requirements, are important factors to the survey respondents. Three levels of service, or tiers, are then offered to meet the ship/shore communications needs identified in this study.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ACKNOWLEDGEMENT

Many thanks to my wife, Donna, whose patience, understanding, and encouragement made it all possible and to Professor William Gates, whose guidance made this project an interesting learning experience.

I. INTRODUCTION

A. BACKGROUND

The Coast Guard has long been collecting data on its operations, such as search and rescue cases, number and size of narcotics seizures and the like. For the most part, this data has been gathered, summarized, and used to compile statistics and justify budget requests. In recent years, however, more and more information has been needed by operational units to accomplish their missions. A typical example is information collected about vessels that are boarded by Coast Guard boarding teams. Several years ago, one particular boat, the Motor Vessel ALBERT, was repeatedly boarded by the Coast Guard as it made its way up the Eastern seaboard. The Coast Guard units involved did not have access to timely information regarding the activities of other Coast Guard units and therefore needlessly badgered an innocent boater.

Coast Guard officials have been working toward a solution to this problem. Much time and effort has gone into developing accessible data base systems, such as the Marine Safety Information System and the Law Enforcement Information System. For the most part, access to these systems has been limited to a handful of specialized users ashore, like Marine Safety Offices and District Operations Centers. Access by operational field units (ships, boats, and aircraft) that are underway is theoretically possible but impractically complicated. A data link could be established between the ship or aircraft and a shore facility. This shore facility would provide the interface to a terrestrial data network which has a connection to the data base. An arrangement like this would provide operational units underway with the capability of accessing up-to-date information in a timely and relatively straightforward way. More timely information would allow those units to conduct their business in a more efficient and more professional manner.

B. OBJECTIVES

The purpose of this study is to look at the needs of the Coast Guard for a link from mobile operational platforms to terrestrial data sources [Ref. 1]. Specifically, the data needs of a new patrol boat class, currently in the conceptual design phase, will be analyzed [Ref. 2: pp. 12-14]. This research will examine the patrol boat's data needs as seen through the eyes of the major stakeholders: program manager, operational commander, operational database manager, and operator.

The following specific questions will be addressed [Ref 3: pp.283-290]:

- What is an appropriate measure of the demand for data?
- What are the factors most likely to contribute to demand?
- Which data needs are considered essential and which are merely nice to have?
- How can this problem be explained using basic economic theory?
- What is the ideal system capacity for the patrol boat?

C. SCOPE AND LIMITATIONS

This research will examine the essential characteristics of a data link in economic terms, irrespective of the actual technology employed to establish the link.

D. ORGANIZATION

The body of this thesis is organized into six chapters, each of which addresses a component important to the research questions. Chapter II looks at the proposed new patrol boat class as well as the boat class it is replacing. The two classes are contrasted to discover how new and emerging information technologies changes the way the classes accomplish their missions.

Chapter III introduces economic forecasting theory. A brief discussion of both qualitative and quantitative forecasting methods is presented. In addition, a step by step procedure for developing a forecasting model is described.

Chapter IV selects one of the forecasting methods for the problem presented. A thorough justification is conducted based on the forecast objective, expertise available, historical data and emerging technology.

Chapter V introduces the results of the information collected during this study. The chapter begins with a detailed presentation of the data collection experience. The information collected is next grouped and categorized. Finally, a demand model is synthesized.

Chapter VI introduces some considerations which, although not bearing directly on the system capacity, will be important as the system specifications are drawn. Included in these issues are implementation standards, network infrastructure, transmission media, and database interfaces.

Chapter VII provides a summary of the study and draws some conclusions for the patrol boat design process. Finally, areas of possible future research are listed.

II. PROBLEM DEFINITION

A. POINT CLASS PATROL BOAT

1. Background

The Coast Guard has operated small patrol boats in the 75–95 foot range since the 1920s [Ref. 4: p. 83]. The current version, the POINT class, is shown as Figure 1 [Ref. 5: p. i]. These boats are named for points of land and were built in the early to mid–1960s. The class has passed its projected 20 year life–cycle. Many of the vessels have been modified to extend their service life to 30 years [Ref. 2: p. 3].

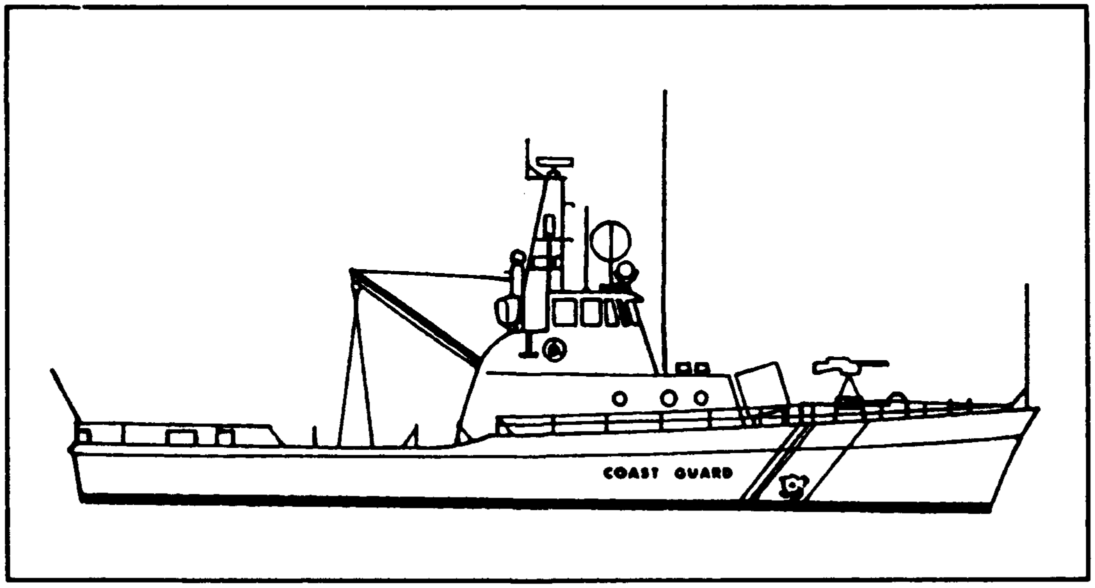

Figure 1: POINT Class Patrol Boat

2. Design Philosophy

The POINT class was originally designed for search and rescue work, but, with the increase in Coast Guard law enforcement activity beginning in the 1970s, the boats were employed for that mission as well [Ref. 2: p. 3]. Often, a POINT class patrol boat will be utilized as the resource of first response for any mission area, including towing buoys and oil spill containment. Appendix A contains a short description of the eight primary mission areas of the Coast Guard. There is usually one patrol boat in high readiness status for a specified geographical area. A quick underway time means that these boats can often take initial control of major situations until relieved by a larger, more capable cutter.

3. Cutter Characteristics

a. Basic Characteristics

The following characteristics are from the *Organization Manual for Patrol Boat (82')* [Ref. 5: p. ix].

- Length 82 feet, 10 inches.
- Economical cruising speed of 8 knots.
- Maximum speed of 22 knots.
- Operating range 1580 nm.

b. Command, Control and Communications Capabilities

POINT class patrol boats have a relatively simple communications suite. Originally, they were designed around VHF line of sight voice radio. To this have been added both HF and UHF voice radio, clear and secure. All of these systems significantly expand the possible operating area of the vessel class. However, they do not substantially increase the type of information that can be relayed. The most important command, control and communications characteristics include:

- Underway: Capable of voice communications only.
- Capable of participating in a Vessel Traffic System via voice only.
- Capable of accepting external search planning data by voice only.
- Coast Guard compatible data communications system ashore only.

Some areas have made modifications to the POINT class communications capability. To be noted is the Thirteenth District's packet radio system. A packet controller allows message traffic, composed at an onboard personal computer, to be transmitted over the VHF-FM radio network. This in essence provides record traffic to and from the vessel while underway.

B. COASTAL PATROL BOAT

1. Background

A replacement for the POINT class patrol boat will be needed in the mid-1990s timeframe. Current plans call for delivery of production cutters in 1994 [Ref. 2: p. 3].

2. Design Philosophy

The new Coastal Patrol Boat will be employed for many different types of missions, such as law enforcement, search and rescue, and marine environmental response, to name a few [Ref. 2: p. 3]. Thus the design must be flexible to allow for the different demands of the various missions.

Another important consideration which must be "designed in" is minimal manning. An underway watch section of two people and an in port section of one are assumed [Ref. 2: p. 6].

A third major design criteria is availability/maintainability. Most minor systems will be modular in design so that they can be replaced quickly by the crew and repaired by facilities ashore [Ref. 2: p. 6]. Patrol boats typically have a great deal of time either underway or in a high readiness status.

3. Cutter Characteristics

a. Basic Requirements

The following characteristics are from the "Sponsor's Requirement Document" [Ref. 2: pp. 9-12].

- Length suitable to use present POINT class facilities.
- Economical patrol speed of at least 12 knots.
- Maximum speed of at least 30 knots.
- Minimum of three days unsupported endurance.
- Minimum operating range of at least 1000 nm.

- Two compartment damage stability.
- Design life of at least 25 years (hull and components).

b. Command, Control and Communications Requirements

An assumption is that the Coastal Patrol Boat will operate in the near-offshore region (0-200 nm) under the operational control (OPCON) of a group [Ref. 2: p. 12]. A brief explanation of these command relationships can be found in Appendix B. Some of the important command, control and communications characteristics include: [Ref. 2: pp. 12-13]

- Underway: Capable of sending tactical data to the controlling Opcenter. Included are operational notes, track data, cutter position, and sensor data.
- Capable of exploiting information from off-board sensors.
- Communicate with non-Coast Guard resources including DoD, federal and local law enforcement agencies.
- Open architecture which allows flexibility over the projected life span.

C. CONTRASTS IN PATROL BOAT DATA REQUIREMENTS

The most obvious difference between the two classes of patrol boat just described is the POINT class' lack of any non-voice transmission capability, save for local, non-standard solutions. This limitation places the burden for all ship/shore communications on the bridge crew, and on the available voice circuits.

The Coastal Patrol Boat is being designed as a multi-mission platform. As such, its communications capabilites must be flexible enough to accommodate diverse spectrum of potential operations. On one hand, the cutter must be able to communicate directly with the public, as in search and rescue. On the other hand, missions like law enforcement and military operations require controlled, secure communications. The POINT class, by contrast, was initially configured for the search and rescue mission. Other communications capabilities have been added as new missions were assigned.

The Coastal Patrol Boat will have the requirement to receive external data generated by "off-board sensors and databases." [Ref 2: p. 12] POINT class vessels, again, must copy all such information over the voice channel. This is an important distinction. The missions for which the Coastal Patrol Boat is being designed are vastly more complicated than those for which the POINT vessel was built. Modern professionalism demands that full use of available technologies be made to best serve the public.

In port, the Coastal Patrol Boat will be able to send sensor data to a central monitor, allowing it to lie at moorage under a one person watch [Ref. 2: p. 11]. The POINT class boats have only a rudimentary sensor/monitor system.

One can see that ship/shore data communications will be an integral part of the new patrol boat. The question arises, then, of just how much data communications will be needed to optimally operate the vessel. To analyze this question we turn to economic theory and the laws of supply and demand.

III. ECONOMIC THEORY

A. SUPPLY AND DEMAND

"Economics is (a) the study of how individuals and societies deal with scarcity and (b) the development of methodologies for analyzing such problems." [Ref. 6: p. 2] Economic principles can be applied to all sorts of problems that deal with scarce resources, not just commodities.

1. Supply

For any given resource, a supply schedule is a table showing the different quantities of the resource that would be supplied at a variety of prices. A graph of the supply schedule for a resource, as shown in Figure 2 [Ref. 7: p. 38], is the supply curve and is typically upward–sloping. This indicates that suppliers would be willing to supply more of the resource at a higher price than at a lower price. The actual shape of the supply curve incorporates many factors: price of materials, technological know–how, prices of substitute goods, the goals of the suppliers, etc [Ref. 6: p. 90].

2. Demand

Like supply, demand for a resource can be shown in a demand schedule and the corresponding demand curve constructed. The typical demand curve is downward–sloping, as depicted in Figure 3 [Ref. 7: p. 30], since consumers would tend to use less of the resource as the price increases. Again, the shape of the demand curve is dependent

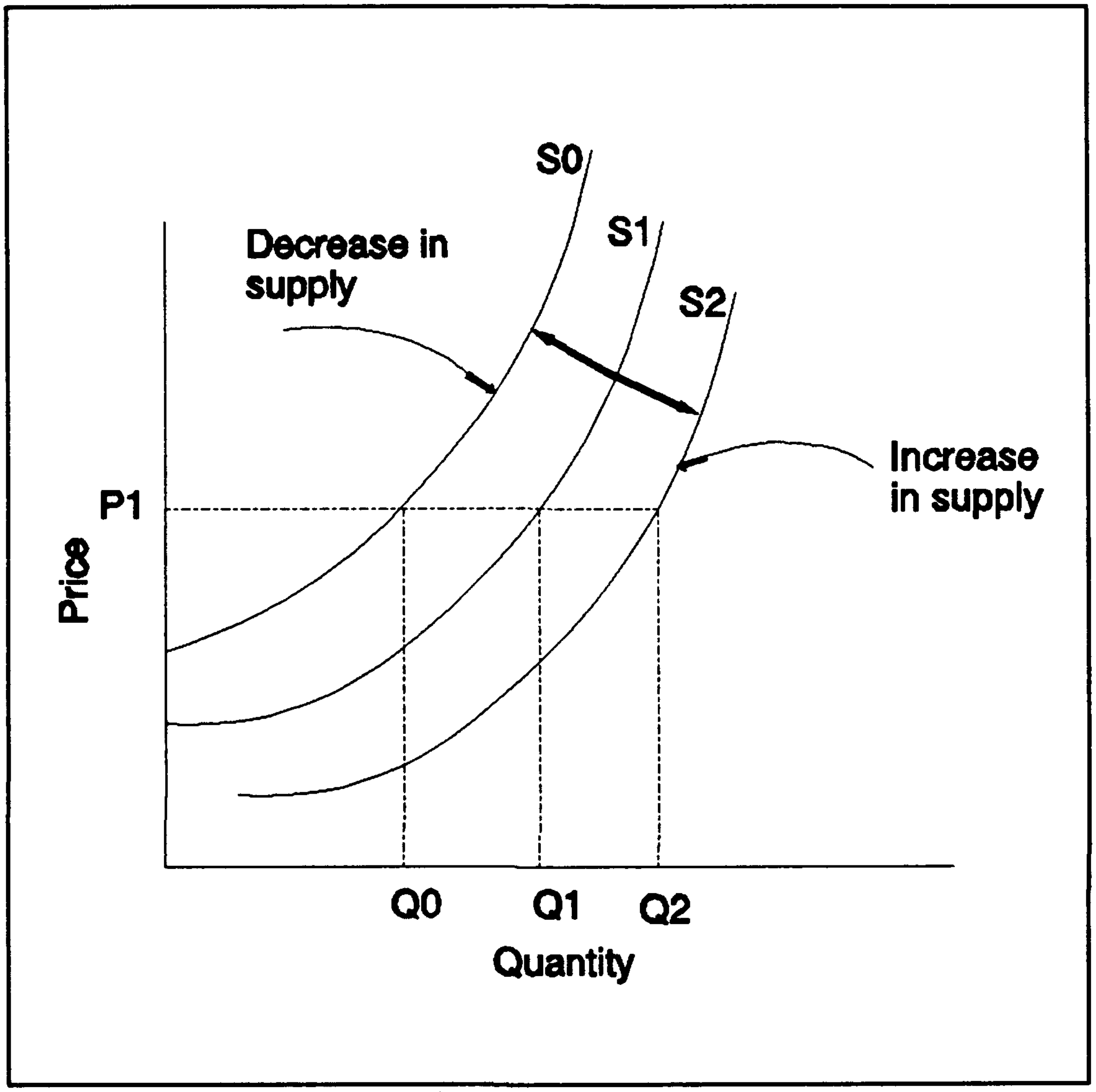

Figure 2: Typical Supply Curve

on several other factors, such as taste, income, substitutes, and complements [Ref. 6: p. 86–87].

3. Market Equilibrium and Optimal Performance

Economic theory maintains that, in the long run, "the market will converge to the equilibrium price–quantity combination." [Ref. 8: p. 31] This is to the point

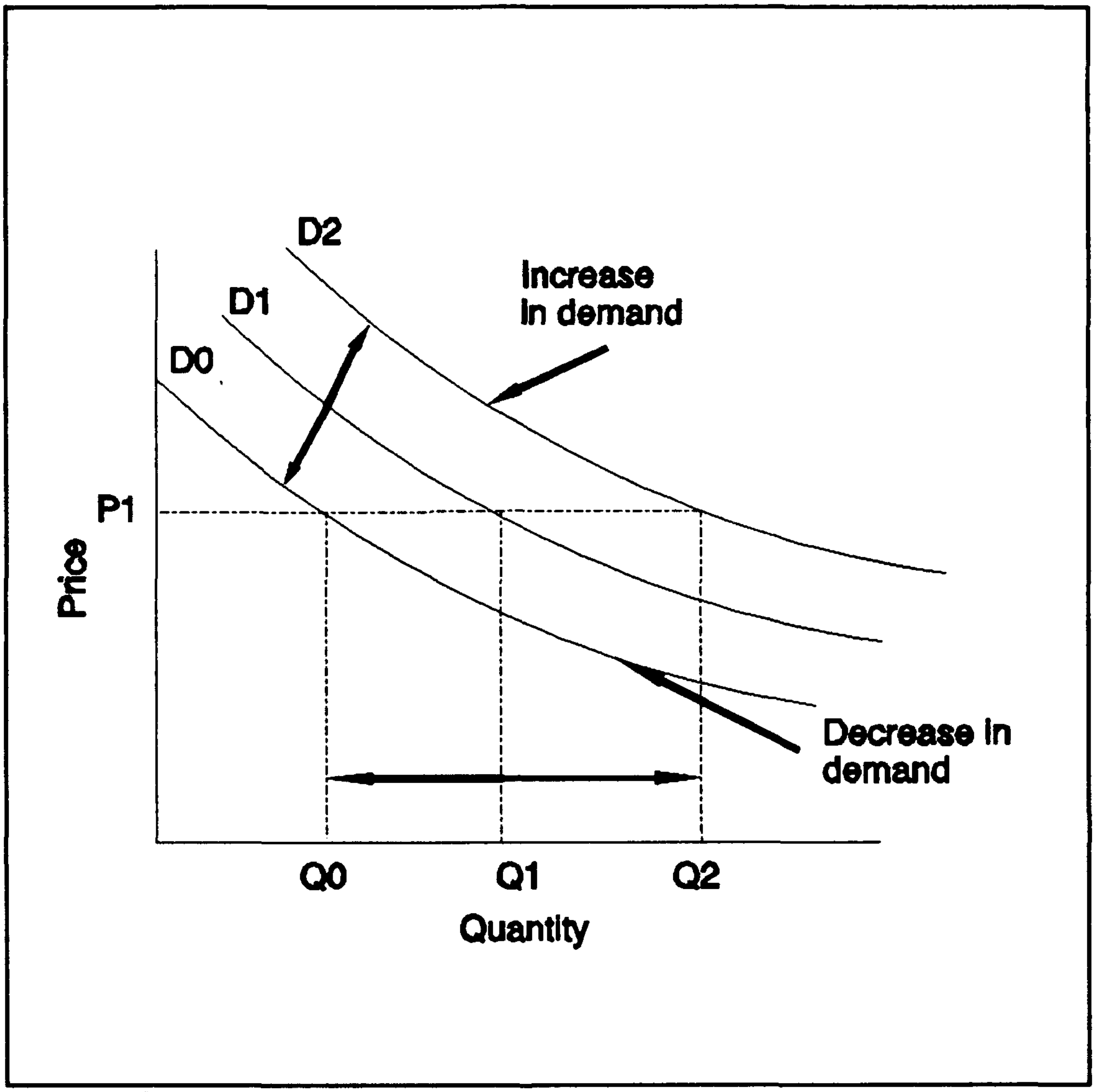

Figure 3: Typical Demand Curve

where demand is equal to supply. This can be explained by simple analysis:

> When there is excess supply (the quantity supplied exceeds the quantity demanded), supplier firms compete with one another and drive down the price. When there is excess demand (quantity demanded exceeding quantity supplied), buyers compete with one another and drive up the price [Ref. 6: p. 94].

From the supply and demand relationships, with the addition of cost information, one can determine the total costs and benefits for each level of production.

These relationships are shown in Figures 4 (a) [Ref. 7: p. 43] and (b) [Ref. 6: p. 258]. The result is an unconstrained optimization problem for maximum total profit:

Optimize: $$\pi = B - C$$

with respect to the level of output, Q.

Maximization requires: $$d\frac{\pi}{dQ} = d\frac{B}{dQ} - d\frac{C}{dQ} = 0$$

Thus, profit is maximized when $$dB = dC.$$

[Ref. 8: p. 45]

These two terms, called marginal benefit and marginal cost, will be equal when the benefit from providing one additional unit is exactly offset by the cost of providing the unit.

We can see that, in any given market, supply and demand move toward an equilibrium point and the system is optimized when the marginal benefit equals marginal cost. But we must know what these supply and demand curves will look like in practice in order to determine the optimal allocation of resources. To explore this problem we turn to the subject of demand forecasting.

B. DEMAND FORECASTING THEORY

There are two categories of approaches to the problem of determining future need or demand for a good or service: qualitative models and statistical models [Ref. 8: p. 190].

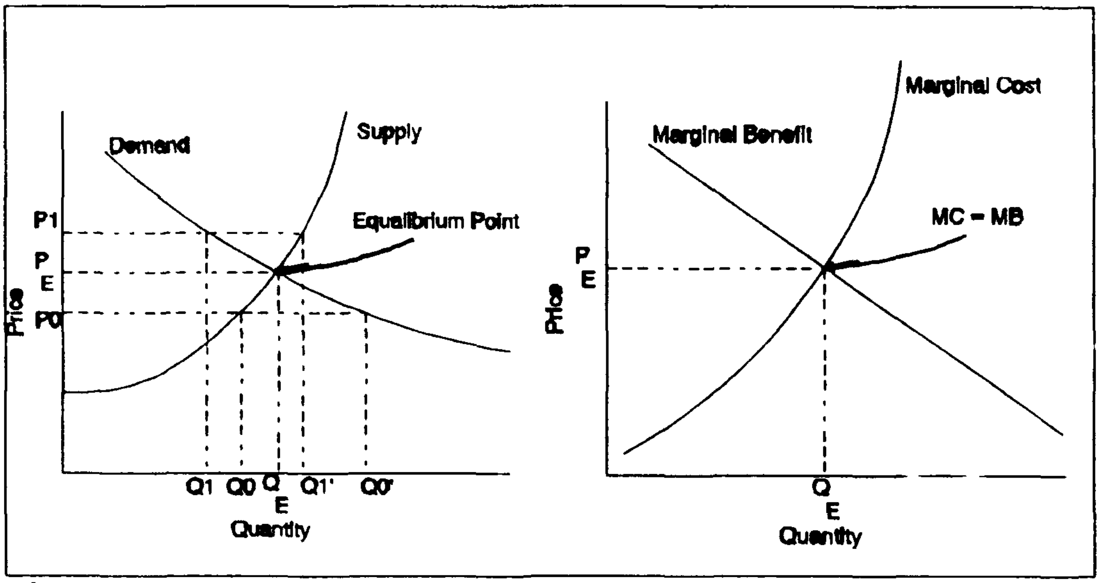

Figure 4: (a) Supply & Demand
(b) Marginal Benefit/Marginal Cost

1. Qualitative Models

Qualitative techniques are largely subjective or based on heuristics. They are best employed when there is little historical data and no apparent correlation between current information and expected trends [Ref. 3: p. 15]. In the business world, a set of leading indicators are often used to highlight expected industry trends so that experienced decision makers can make educated predictions about what the future might bring [Ref. 8: p. 195].

The Delphi method is another popular technique which falls in this category. Delphi method, or Delphi technique, attempts to arrive at a consensus among a group of experts, without biasing the results through group dynamics effects [Ref. 3: p. 15]. Other qualitative methods include market research, panel consensus, visionary technological forecasts, historical analogue, role playing, decision trees and system dynamic modeling [Ref. 3: pp. 15–19].

2. Statistical Models

Statistical models can be further divided into two categories: time–series models and econometric models [Ref. 8: p. 199]. A time–series is a collection of data on a parameter at ordered intervals of time [Ref. 3: p. 20]. Through analysis, several different characteristics of the parameter can be isolated. Many time–series can be decomposed into several parts, consisting of the trend or general tendency, seasonal or cyclic pattern, and an irregular or "hash" pattern, as shown in Figure 5 [Ref. 9: p. 22]. [Ref. 9: p. 20]

Econometric models are based on "an explicit structural model that attempts to explain the underlying economic relations." [Ref. 8: p. 209] Usually, econometric models are based around one economic theory and developed as a linear program. Although the form of the model can be quite simple, actually solving the equations is another matter. The number of constraints can grow very large as the modeler attempts to include all relevant factors [Ref. 9: p. 118].

How does one decide which of these various approaches to choose for a given problem? For the most part, these different techniques can be grouped by the characteristics of the final decision which is being made. As an example, qualitative methods are very appropriate for forecasts made with a time horizon of medium term (3 months to 2 years) to long term (2 years or more) [Ref. 3: p. 27]. Table I is a summary of these techniques and characteristics. Typical characteristics to consider include the

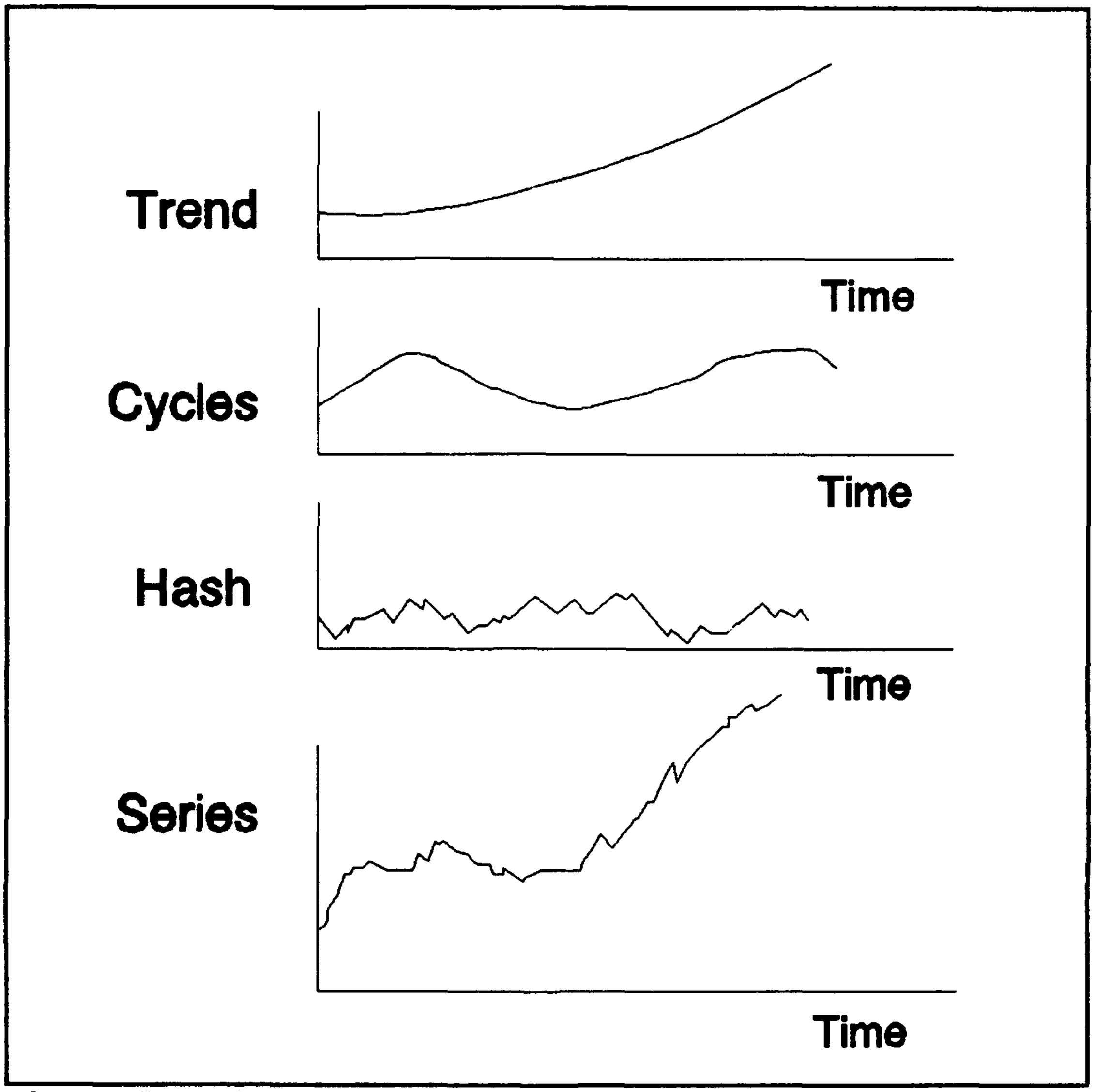

Figure 5: Time Series Decomposition

amount and type of data available for analysis, the time horizon, accuracy needed, time available to conduct the analysis, and costs of model development [Ref. 3: pp. 26–32].

Another factor to take into consideration is the type of forecast that is being contemplated. Is it to be a point forecast, that is, one particular value for one particular time in the future, or an interval forecast, covering a likely range of values [Ref. 9: pp. 9–10]?

Table I: COMPARISON OF ANALYSIS AND FORECASTING TECHNIQUES

		Qualitative					Quantitative										
							Statistical							Deterministic			
		Delphi method	Market research	Panel consensus	Visionary forecast	Historical analogue	Summary statistics	Moving average	Exponential smoothing	Box-Jenkins	TCSI decomposition	Trend projections	Regression model	Econometric model	Anticipation survey	Input-output model	Leading indicator
Pattern of data that can be recognized and handled	Horizontal	Not applicable					x	x	x	x	x	x	x	x	x	x	x
	Trend						x	x	x	x	x	x	x	x	x	x	x
	Seasonal						x	x	x	x	x		x	x			
	Cyclical						x			x	x		x	x			
Minimum data requirements		Not applicable					5 Points	5-10 Points	3 Points	3 yrs by mo.	5 yrs by mo.	5 Points	4 yrs by mo.	4 yrs by mo.	2 yrs by mo.	> 1000	6 yrs by mo.
Time horizon for which method is most appropriate	Short term (0 - 3 mos.)		x	x			x	x	x	x	x	x	x	x	x		x
	Medium term (3 mo - 2 yr)	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
	Long term (2 yrs or more)	x	x	x	x	x	x					x	x	x		x	
Accuracy (scale of 0 to 10: 0 smallest 10 highest	Predicting patterns	5	5	5	5	5	2	2	3	2	7	4	8	2	2	2	2
	Predicting turning points	4	6	3	2	3	NA	2	2	6	8	1	5	7	8	0	5
Applicability (scale of 0 to 10: 0 smallest 10 highest	Time required to obtain forecast	4	8	4	3	5	1	1	1	7	5	4	6	9	5	10	3
	Ease of understanding and interpreting the results	8	9	8	8	9	10	9	7	5	7	8	8	4	10	3	10
Computer costs (scale of 0 to 10: 0 smallest 10 highest)	Development	Not applicable					0	1	1	8	6	3	5	8	NA	10	4
	Storage requirements						4	1	1	7	8	6	7	9	NA	10	2
	Running						1	1	1	9	7	3	6	8	NA	10	NA

Source: Ref. 3: pg. 27

Still another factor which may impact the analysis method is the stage of the product or service's life cycle for which the decision is made. Some research has indicated that certain methods are best suited for products or services in a particular phase of the life cycle [Ref. 3: pp. 33–34]. As an example, the product introduction phase is often best served by qualitative methods, since there is little or no historical data on which to base a quantitative analysis [Ref. 3: p. 34].

C. MODEL DEVELOPMENT

Once an appropriate forecasting model has been selected, the parameters of the model must be specified. Levenbach and Cleary have developed a seven step process of refining and applying a forecast model: [Ref. 3: pp. 283–290]

First, define one or more appropriate measures of demand. What, exactly, is it that one is trying to measure? Is it best described in terms of a number, an interval, or a rate? Can the measure be described in quantity only, or is there an appropriate monetary measure that can be substituted?

Second, use economic theory and marketing knowledge to identify the most likely determinants of demand. There are many factors which contribute to demand, as discussed above. Which of these factors will have a significant bearing on the parameter being measured? Which will have only minor relevance and which will have none? What environmental elements should be considered?

Third, collect historical data on demand and its likely determinants. Is the data best collected as one service for one particular area at given intervals of time (the time–series format); as one service over various geographical area for one historic period (the cross-sectional format); or in a combination or "pooled" format [Ref. 3: p. 287]? Is the data readily available, or must it be culled from other records or collected from scratch?

Fourth, use statistical estimation procedures to identify and validate the most likely structure for the demand model. What general model form seems to best fit the collected data? Do the response parameters fit the data? Is the model consistent?

Fifth, use the demand model to generate price–demand and other demand response relationships. This step should give one the demand function required plus any ancillary functions needed to determine the various function parameters.

Sixth, use the demand model to generate conditional demand forecasts. The model generated thus far is conditional on the underlying deterministic parameters. The problem becomes one of forecasting the value of the parameters. Which are likely to change and which remain constant? How much dissent is there about the assumptions?

Seventh, track the model forecasts and actual product/service demand. Use the differences between them to guide future model refinements and make preliminary elasticity estimates of new marketing instruments. By continuously evaluating forecasted results with actual results, the model can be fine tuned. Although the utility of a given model usually diminishes over time, in a well constructed model it will be some time before the difference between the predicted and actual results grows too big.

What are the advantages of using this or a similar procedure to obtain design characteristics? First, all of the assumptions are made up front and placed on the table so that all parties involved can comment on them. Disagreement over the assumptions can be the basis of a sensitivity analysis and/or of assigning probabilities to each of the disputed factors. Second, modifications to the model are much easier to introduce if all factors have been included from the beginning.

A discussion of forecasting and modelling would be incomplete without a word about uncertainty. One way of integrating uncertainty into the forecasting model is by using confidence intervals around the parameters in the model. This in effect spreads the variable being predicted. Thus, a point becomes an ellipse and a line becomes an area. As the forecast is made further into the future, the uncertainty increases, not arithmetically but geometrically, as depicted in Figure 6 [Ref. 8: pp. 215–216].

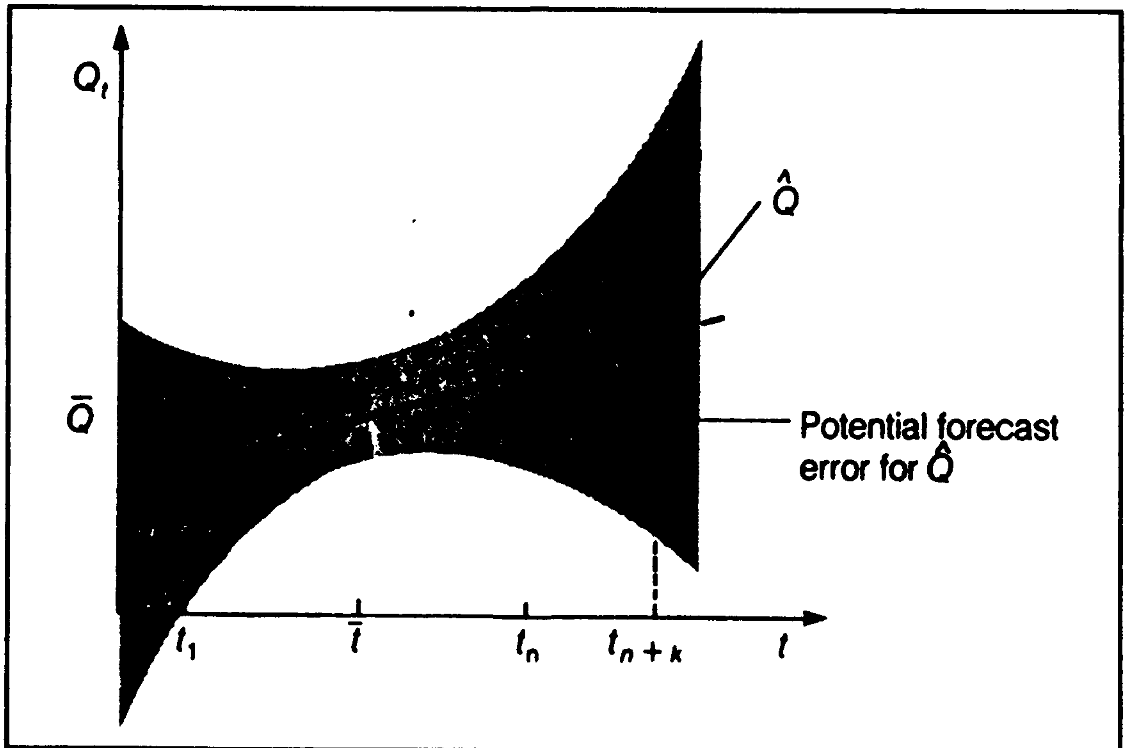

Figure 6: Confidence Intervals

IV. MODEL SELECTION AND DEVELOPMENT

A. FORECASTING MODEL SELECTION

Table I from Chapter III is an excellent departure point in formulating a model for Coastal Patrol Boat ship/shore data requirements. A summary of the existing data characteristics is in order.

- No accurate data exists for establishing current (POINT class) requirements for shoreside database access.
- The time horizon for the forecast is long term (greater than 2 years).
- The forecast must be reasonably accurate at predicting the overall pattern but has significant allowance for uncertainty.
- The time in which to make a forecast is rather limited. The results are needed relatively soon.
- The forecast must be relatively easy to understand and interpret.
- Computer modelling costs are not constrained.

Each of these characteristics will be developed and analyzed below.

1. Historical Data Availability and Accuracy

With the notable exceptions mentioned previously, there is no mechanism at present for POINT class patrol boats underway to conduct real-time, direct queries of databases ashore. This fact has two important consequences on the problem under consideration.

First, any data available recording database access by vessels in this class will be incomplete, at best. Queries must be made by voice to the Operational Commander, who then makes the actual database query. The results must then be relayed back to the patrol boat by voice. The record of access maintained by the computer center will thus show access by the Operational Commander, not the unit actually requesting the information [Ref. 10: pp. 2-6].

Second, in a number of cases, the inherent time delay in the present system will predispose the commanding officer of the patrol boat to forgo making an intelligence query. [Ref. 11] One can argue that the present system is not meeting the data needs of the patrol boat fleet if the system is too slow or cumbersome to be used on a routine basis. Most commanding officers will request additional information on an obviously suspicious boat, but may not for an unnotable vessel engaged in routine operations.

An indirect method of measuring the current data need might involve counting the actual sightings reported by a vessel while underway and postulating that a data query would ideally be done on each vessel. This assumption is likely in error. A patrol boat will usually include vessels on its sighting report with which it is familiar. The analogy is of a police unit running a license check on every car it sees on the highway. While the vessel is listed on the sighting report, requesting additional data by querying a shoreside database is overkill. The argument can be made that such an analysis of the sighting report base would at least provide an upper bound on the data need. Since this method is indirect to begin with, the best that could be expected would be some very approximate results. Thus, it seems that there are no historical data documenting the current patrol boat data needs.

2. Time Horizon

The Coastal Patrol Boat is currently slated to begin operations in the 1994 time frame [Ref 2: p. 3]. As performance specifications are nearly completed, operational needs are being forecast at least 3 years into the future. This is considered a long term forecast [Ref. 3: p. 22].

3. Forecast Accuracy

The whole point of designing a cutter and developing performance specifications is to procure a vessel which meets the mission needs. This is always compromise in design and equipage. Usually, designs include a growth potential, to allow for modifications and improvements in the vessel without exceeding stability and habitability limits. The Coastal Patrol Boat is no different [Ref. 2: p. 12, 14].

The area of communications is both a blessing and a curse in this regard. On one hand, communications technology is changing so rapidly that it is practically impossible to have an accurate assessment of off-the-shelf technology only a year or two into the future. Capabilities presently in research may well be commercially available by the time the new vessel is fielded. On the other hand, the trend in communications is for advancements to pack more capability into smaller and lighter packages. This means that an upgrade in the middle of the life cycle will likely add capability while at the same time reducing space requirements [Ref. 2: p. 5].

The problem, then, is to estimate the level of service needed in the early operational life of the cutter. We need not be concerned with turning points. Since technological advancements will undoubtedly overtake the planning and procurement process in this area, the goal should be to make a reasonably accurate forecast. Fine-tuning can be done as the ships are actually added to the fleet, and later in a mid-life upgrade.

4. Time to Forecast

The current study has a firm completion date, allowing for approximately five months of analysis and development. The Sponsor's Requirement Document was being prepared for input into the FY93 planning and budgeting cycle. The input is required in the spring of 1991. This time factor allowed for six months of development between the first draft of October 1990, and the second draft of April 1991.

5. Ease of Interpretation

This forecast is being formulated for a variety of people, including engineers, information systems technicians, sponsors, and vessel operators. It must be understandable to all.

6. Computer Resources

The computing resources of the Naval Postgraduate School computer center are available to process quantitative models. In addition, a number of microcomputer systems are available, including the Naval Postgraduate School Information Systems microcomputer network, the Operations Research microcomputer network, and a Coast Guard Standard Workstation network.

From Table I, the two methods which most closely match these characteristics are the qualitative Delphi and visionary forecasting methods. Visionary forecasting is primarily used to predict the next generation of technological breakthroughs [Ref 3: p. 17]. Current research activities and previous milestones are analyzed and evaluated. Between these two methods, Delphi will best suit the current situation.

B. DELPHI METHODOLOGY

Delphi is a family of methods which attempt to arrive at a group response while avoiding the pitfalls of direct confrontation. "Proponents of Delphi emphasize that it incorporates the advantages of groups while minimizing the disadvantages." [Ref. 12: p. 34] The classic Delphi technique was developed by the RAND Corporation in the late 1960s [Ref. 12: p. 31]. Typically, a panel of experts is given a questionnaire and asked to give an opinion or make a forecast in the subject area [Ref. 12: p. 31]. The questionnaires are summarized and a list of predictions or courses of action are compiled. These results are then redistributed to the panel to reconsider, after assessing the opinions of the other experts listed in the results. This process is continued for a total of four rounds, with each successive round requiring more rigorous justification and rationale from the experts [Ref. 12: pp. 31-32].

There are several advantages to Delphi. First, the panel "brings to the problem situation more total information than that possessed by any single member." [Ref. 12: p.

33] Second, a group can consider as many, or more, factors than an individual. Third, groups tend to be more willing to take risks than individuals [Ref. 12: p. 33].

There are three characteristics of Delphi which distinguish it from other methods of group decision making [Ref. 12: pp. 34-36].

- Anonymity. Group members are not known to each other. This facilitates consideration of views on their merits, rather than on the status of the person who originated the view.
- Controlled feedback. Panel members receive the opinions of the other members only after they have been filtered by the process director. The director has the opportunity to remove biases, references to position or status, and other influential material which could sway opinions.
- Group statistics. In addition to a final, majority opinion, the director has precise data on the degree of consensus. This is true not only of the majority opinion but also of the other alternatives considered and rejected by the panel.

There are several variations on the classical technique [Ref. 12: pp. 36-40]. One substitutes a blank paper for the initial questionnaire, in the belief that the experts know more about the subject than the process director. A second variation puts the problem into a given context by postulating a set of assumptions as given information. A third variation changes the number of rounds, from as little as two to as many as five. Other variations change one or more of the basic Delphi characteristics, such as anonymity or group statistics.

C. RESEARCH PROCEDURE

The blank paper Delphi method will be used. The panel members have enough experience with this problem area that it is not necessary to seed the responses. A questionnaire could restrict the possible breadth of opinion. Two rounds will be used. Each panel member will be solicited for his solutions to the problem, on a blank paper. Then, the initial results will be compiled and each panel member provided an opportunity to comment on them.

An appropriate measure for demand must be selected. In many ways a quantitative data rate, such as 56 kilobits/sec would be ideal. However, such a measure is static in that advances in data transmission technology cannot be captured. For example, while today it may require 384 kbps to send a standard quality full motion video image, that does not mean it will take as much in a year or two [Ref. 13: p. 111]. A better option, then, is to specify a level of service that is required. At any given point in time, current technology can be applied to the service level and a definitive data rate obtained. To continue the above example, if a level of service is defined that requires full motion video transmission of every boarding, then current technology maintains that a data rate of approximately 384 kbps is needed [Ref. 13: pp. 111-113].

The major factors contributing to demand function are likely to be income and the price of substitutes [Ref. 6: p. 86]. The income factor corresponds to the budget which is eventually approved to procure these vessels. A tight budget may mean that low levels of service are chosen. Substitutes, in this case, consist of the many other ways of sending and receiving the same data. Examples include voice transmissions, messages in a bottle, and hold-until-in-port. These trade-offs must be made by the sponsor [Ref. 3: p. 14].

V. DATA ACQUISITION AND PRESENTATION

A. PROCEDURE IMPLEMENTATION

A number of experienced Coast Guard officers, known as the panel, were asked to provide their opinion on this topic. These opinions were obtained as a series of informal telephone interviews, personal interviews and interactive electronic mail exchanges. This data was gathered between 6 January and 3 June 1991 [Ref. 11]. Specific comments and recommendations regarding this process are detailed in the last section of this chapter.

B. THE PANEL

The expert panel used for this process can be categorized into four groups. Each group brings a different view to the problem. A complete listing of the persons involved can be found in Appendix C.

- Patrol Boat Skippers. This group consists of members who have actually commanded the POINT class patrol boat underway.
- Operations Ashore. This group consists of members who have exercised operational control of POINT class patrol boats. The group contains Group Operations and District Operations Center officers.
- Database Manager. This group consists of members who design and/or operate Coast Guard databases.
- Program Manager. This group consists of the Coast Guard Headquarters program managers who develop and maintain the new Coastal patrol boat requirements document.

Several of the people interviewed come under more than one category. For example, it is common for patrol boat skippers to serve a subsequent tour at a District Operations Center. To preserve the anonymity feature of Delphi, specific views are not attributed to any one person in this survey.

C. PATROL BOAT SKIPPERS

1. Law Enforcement

Every patrol boat skipper identified law enforcement data as critical to mission performance. Specifically, skippers want to have access to current vessel information, including registration, whether or not the vessel is suspected or wanted, and recent boarding information with violations noted. They also want information about the people aboard, such as outstanding wants or warrants.

All skippers said that they did not rely on current EPIC checks to make boarding decisions. They called in an average of only 20% of their vessel sightings for EPIC checks, which take approximately 35-45 minutes to complete. Most replied that they would check close to 100% of their sightings if they could receive a response within 5-10 minutes. They would also use this information to make boarding decisions rather than using it as additional information after deciding to board, as is now the case.

The majority of the skippers felt that some general vessel information is important in making an initial boarding decision. Additional information about the vessel and persons can be received after the decision to board is made and the preparations for the actual boarding are underway.

All skippers felt that the ability to receive graphic pictures of vessels and people would be beneficial. Most felt this capability would be nice to have but not essential for the mission.

2. Navigation/Track Reporting

All skippers felt that automated vessel position and track transmission would be a beneficial capability. Most indicated that current reporting requirements (of OPCON) are not burdensome. However, there was a great deal of concern about the loss of autonomy for the vessel and crew if OPCON had the ability to "look over their shoulder" every time the vessel was underway. The biggest benefit was considered to be during actual case prosecution, as opposed to general patrolling. For example, all thought that periodic automatic position reports would be helpful during long offshore tow cases. In such situations, opinion was divided between 15 minute and 30 minute reporting.

3. Sensor Information Sharing

All skippers thought that there is an urgent need to have some capability to receive near real-time data from off-board sensors. Of particular interest was the ability to receive sighting information from Coast Guard and Navy aircraft conducting law enforcement patrols. Current effectiveness of such patrols was considered to be less than optimal due to the time delay of information transferred from the aircraft to the cutter. Basic information, such as the vessel name, course and speed, and any suspicious characteristics is what is desired.

Of secondary importance to the skippers is the ability to send and receive track data to and from large cutters conducting multi-unit law enforcement patrols. Only about half of the skippers had participated in such patrols. Of those who had participated, most thought that such a capability would be nice to have but that the infrequency of the operations does not justify a special capability.

Skippers thought that track data was adequate for sharing. "Value added" was the term used by one respondent. Most saw no need to transmit either raw or processed radar video. Likewise, none saw the need for sending full motion video, a boarding in progress, for example.

4. Decision Aids

Most skippers considered decision aids to be checklists they maintain for evolutions aboard ship. Law enforcement and damage control flow charts are two examples. They felt that aids like search planning programs would be nice to have but not essential since the boats are usually employed as search platforms. It made no difference to them whether such aids were resident on their shipboard computer or kept locally at the group, as long as they could get direct access to them, if needed.

A few skippers were concerned about the possibility of reducing command decision making to following a path on a flowchart. They cautioned against any system that was too inflexible or diminished the importance of the commanding officer's judgment.

5. Weather Reporting

POINT class patrol boats do not routinely report weather. The skippers felt that automating this function would save some time during actual case prosecution, when weather does become a factor. As a group they were concerned that instrumented sensors might be given undue credibility over the skipper's own assessment about how the weather is affecting his boat and crew and their ability to accomplish their mission. Several skippers felt that having up-to-the-minute weather information would help the shoreside decision-makers make better decisions.

One skipper felt that automated synoptic weather reporting could be an additional service to the public with no real cost. The degree of automation would determine whether or not there is any additional workload on the crew.

6. Command and Control

All skippers felt they would significantly benefit by having the capability to receive tasking messages, search plans and the like from OPCON. Further enhancements, such as the ability to upload search coordinates directly into the navigation suite would be big time savers and reduce the possibility of errors in transcribing and manually keying multiple positions.

7. Damage Control

All skippers agreed that the capability to transmit damage control data would not persuade them to forgo a live in port watch. A couple of skippers liked the idea of a remote central monitor for damage control sensor, which could then be monitored from the bridge or from the ship's office ashore. Several of the skippers saw no point in transmitting any damage control data off the ship.

One skipper introduced the idea of remote sensors for remote spaces while underway. For example, the peak tank space on the POINT class is inaccessible in rough seas. The remote sensors would provide the skipper with at least some information about the space's integrity.

8. Automated Report Generation

Most skippers felt that any capability to generate and send reports while underway would be very beneficial. Currently, all sighting reports, boarding reports, situation reports, and casualty reports, as well as administrative messages must wait until the vessel returns to port before they are sent. Often, after a three day patrol, this situation requires senior crewmembers to spend the first several hours after returning to port generating these messages.

Of even greater importance, more timely transmission of sighting and boarding information would allow other units, also on patrol, access to this information while it can still operationally benefit them.

Most of the skippers did not identify any kind of automatically generated reports. However, all were in agreement that anything which would save them time either underway or in port would be beneficial. Two skippers commented on the large amount of redundant data required on the various reports they wrote. Both observed that a system which could automatically route the needed data to appropriate program manager without additional input by the patrol boat would be extremely beneficial.

One idea which surfaced was automatic maintenance of fuel status and time underway. These two factors are most critical in determining the vessel endurance, based on speed, and the crew endurance, based on fatigue standards.

D. OPERATIONS ASHORE

1. Law Enforcement

All respondents agreed that the current method of obtaining law enforcement data for patrol boats underway is inefficient. Vessel information is copied down by hand from voice radio transmissions. Next, telephone calls to various intelligence repositories, such as EPIC, TECS, and local law enforcement agencies are made. In addition, hand searches of stolen vessel lists, lookout lists, and the like are conducted. The result is a bulky, time-consuming process that does not provide timely operational information to the requesting cutter. One respondent commented that he felt like he was a "scribe from the 13th century."

2. Navigation/Track Reporting

All respondents felt that an automatic vessel position and track reporting capability would greatly enhance the operational effectiveness of the ashore command. Some respondents claimed they were embarrassed not knowing the location of their patrol boats when underway. An important point is that the reporting must not require additional attention from one or more crewmembers. Most felt that any loss of autonomy felt by the boat crew was more perceived than real, since the groups can always find out the current position of a patrol boat now anyway, just by asking on the radio. All felt that the pros of automated position reporting outweighed the cons.

Most respondents thought that track reporting during actual searches would provide a real-time measure of search effectiveness, where the boat actually was as opposed to the planned search track.

3. Sensor Information Sharing

All respondents thought that there needs to be a capability to share sensor information. Opinion was divided as to what information needed to be shared. All agreed that track information from off-board sensors, such as search aircraft, as well as track information from the patrol boat should be transferable. Most did not see any benefit from transmitting raw data, such as raw radar video, and, indeed, were concerned over the prospect of data overload at the tactical command center.

One respondent observed that sharing information about the search platform itself would allow the patrol boat to "virtually track" the units it is working with, a capability the boats do not currently have.

4. Decision Aids

Most respondents thought that decision aids, other than mere checklists, would rarely be used on the patrol boat and would be better maintained at the group.

A few respondents thought that access to current policy and procedure would be very beneficial to the underway boats. Many Coast Guard policies change periodically while some situations might occur only once during an entire tour, if at all. Providing access to a central repository of general and local operational policy was considered to be very beneficial. The example which was cited is the set of Quick Response Cards kept at the group operations center, which could be made available to the boats underway.

5. Weather Reporting

All respondents thought that weather reporting would be helpful but not indispensable. In the extreme cases where weather is a deciding factor, the judgment of the skipper is more important than the numbers from the sensors.

One respondent felt that receiving weather information on the patrol boat, like a weather map facsimile, would be extremely beneficial.

6. Command and Control

All respondents thought that there needs to be some type of command and control data capability. Most were thinking along "traditional Coast Guard message" lines. Operational commanders ashore need to be able to send tasking to a patrol boat underway: go to point A and do X; search for D, using pattern Z; and so forth. In general, alternatives to the current format for this information had not been considered by respondents.

7. Damage Control

Most respondents did not think there is a need to transmit damage control data off of the patrol boat. They would not consider eliminating the live watch aboard the cutter, unless the commanding officer was also relieved of his responsibilities aboard the boat. Two respondents strongly felt that the insistence on a live watch fails to equitably consider the tradeoff of risks versus benefits in this area. This issue led to some fairly strong opinions about the role of the skipper and crew, as well as group-patrol boat relationships, which are not pertinent to the current study.

8. Automated Report Generation

All respondents thought that anything that could save the patrol boats time and provide more timely reports would be very beneficial. Several respondents commented that transmitting information as it was generated (such as sighting reports) would greatly reduce the amount of after the fact reporting.

Two respondents described a system in which an on board computer composed the required operational reports by collecting the various data pieces, formatting them and then transmitting them to the appropriate database.

E. DATABASE MANAGERS

Originally, the managers of a number of Coast Guard databases were to be surveyed, each describing the services he thought would be beneficial to patrol boats. However, essentially all of the data functionality required by the patrol boat skippers can be found in the planned Law Enforcement Information System II (LEIS II).

> The objective of the LEIS II is to selectively consolidate, automate, and electronically distribute to remote Coast Guard elements, law enforcement information having multi-district utility and/or requiring Automatic Data Processing resources not otherwise available to Coast Guard field units. The LEIS II will provide all users of Coast Guard law enforcement information a consolidated decision-support system for their operational missions. A primary design goal is to provide a "One Stop Shopping" environment to support the information needs of law enforcement users. [Ref. 14: p. 1]

LEIS II will be operated from the Coast Guard Operations Systems Center in Martinsburg, WV. It will provide access to a wide variety of law enforcement information, such as vessel sightings and boardings, suspect vessels, vessel descriptions, people descriptions, etc. In addition, a paper-based file of suspect vessel photographs exists. Photographs can be manually transmitted to requesting units via facsimile.

As part of the "One Stop Shopping" concept, LEIS II will be linked to other law enforcement systems. Presently, access to the following systems is being pursued: the National Crime Information Center, the El Paso Intelligence Center, the Treasury Enforcement Communications System, the National Law Enforcement Telecommunications System and the National Narcotics and Dangerous Drugs Information System, as well as the Coast Guard's own Marine Safety Information System. Other system interconnections are also possible.

LEIS II will provide remote access via several means, including dial-up, X.25/TELENET, Coast Guard Electronic Mail, and Defense Data Network [Ref. 14: p. 8]. The method by which Coast Guard units underway will connect to the database has yet to be determined.

The LEIS II System Specification has identified four levels of response time requirements. Real time critical needs (boarding decisions, for example) will receive a response within five minutes. Less critical real time needs will receive a response within fifteen minutes. More general information can be expected within one hour. Finally, non-real time needs require a response within a day. [Ref. 14: p. 10]

As currently planned, LEIS II will be accessible by all vessels 110 feet and greater in length. Smaller vessels will be supported by operational commanders ashore.

F. PROGRAM MANAGERS

Most of the data communications ideas of the program development staff are already included in the Sponsor's Requirement Document. However, several issues in that document are vague and have been elaborated upon.

The program managers described the capability to receive sensor/track information from Coast Guard aircraft and to query shoreside databases such as EPIC, Operations Systems Center and local law enforcement databases while underway. This could include connections to state agencies and Department of Defense components. Tactical data sent to the controlling operations center would be a manual mode that is not self-generating.

Many of the command and control portions of the requirements document may dictate future upgrades to the group communications infrastructure. Most of the "integrated" features of the command and control data described in the requirements were seen as display and manipulation features, rather than an interactive capability. The program manager originally envisioned a crewmember manually inputting data received from the operational commander.

Decision support and expert system tools were primarily considered an on board capability, although some areas, such as search planning, could be accessed from shore. For the most part, tactical data was considered to be processed, or value-added data, as opposed to raw radar video. Examples include historical tracklines, own ships's and radar contacts' position on a graphical chart display, and supporting resources, like aircraft.

G. RESEARCH PROCEDURE CRITIQUE

The blank paper Delphi technique did not work as envisioned. Almost all respondents initially described the hardware characteristics they felt were necessary, rather than the actual information which needs to be transferred. As a result, the process director had to guide the discussion away from the hardware and back to the data issues themselves. This was done by incrementally focussing on data needs, from general areas to specific data items.

The resulting procedure had one significant benefit. The interviews were by and large two-way "conversations", during which the process director could feed back ideas and opinions from the other participants directly.

The classical Delphi technique would have been a better choice for this experiment. As it turned out, the process director had to risk biasing the responses to get the respondents on the right path anyway. An iterative survey, with the initial questionnaire developed by the process director, would have probably returned the same results. In addition, that method would have provided accurate statistics for each question and response to feed back to the respondents as well.

Table II summarizes the results of the survey conducted.

Table II: SUMMARY OF SURVEY RESPONSES

Telecommunications Services	Patrol Boat Skippers	Operations Ashore	Database Managers	Program Managers
Law Enforcement Intelligence: Registration/Documentation Recent Boardings/Violations	Critical	Beneficial	Critical	Critical
Digital Pictures/Facsimile	Helpful		Helpful	
Vessel Position & Track Data	Beneficial	Beneficial		Critical
Ship/Aircraft Data Sharing	Critical	Critical		Critical
Ship/Ship Data Sharing	Beneficial	Beneficial		
Decision Checklists	Beneficial	Beneficial		
Search Planning Aids	Helpful			Helpful
Policy & Procedure Aids		Beneficial		
Weather Reporting	Helpful	Helpful		
Weather Map Reception		Beneficial		
Command & Control Messages	Beneficial	Critical		Critical
Damage Control/Sensor Data				Beneficial
Automated Report Generation	Beneficial	Beneficial		
Layered Response Times	Beneficial	Beneficial	Critical	
Value-added Data	Critical	Critical		
Number of Respondents in category	7	5	2	2

VI. IMPLEMENTATION CONSIDERATIONS

In addition to the services described in the previous chapter, the respondents had some specific concerns about the communications system, regardless of the services it supports. These concerns are briefly discussed below.

A. EASE OF USE

Almost all respondents stated that even the most capable system will not be used if it requires extensive training or commands the constant attention of a crewmember. Crewmembers on a small patrol boat typically must do many jobs in order for the boat to perform its missions. Dedicating one crewmember to operate the data communications equipment is just not practical.

Contributing to the problem of extensive training is the proliferation of data formats. Each Coast Guard information system employs its own format, which is not compatible with the other systems. As a result, the user must learn all of the formats and apply the right one at the right time. The most beneficial system envisioned by the respondents would provide one interface to the user for all of the systems and utilize software to format the data to each individual database. The Coast Guard is currently investigating the feasibility of such a system [Ref. 15].

Another point which was repeatedly mentioned by respondents was that a system that does not facilitate data entry will not be used. The system must be usable from the bridge: almost all shipboard evolutions are directed from the bridge. A system which is secure in a space below decks will not receive much use underway.

While a keyboard is the best known data input device, it has serious limitations when used aboard a rolling patrol boat underway. Several evolving technologies were discussed with a few of the respondents which could have an important impact on the data entry problem. Touch screen is a technology which allows items to be selected simply by touching the video monitor. A trackball is similar to a mouse but does not require the same amount of flat, stable surface to operate. Finally, voice recognition can provide the capability to enter information while the member is also engaged in other activities, such as steering the boat or looking at registration numbers through binoculars.

B. SECURITY

Security was probably the most often mentioned aspect of a data communications link. Coast Guard patrol boats usually deal with information which is at least sensitive and requires some protection. Less frequent, but still commonplace is the need to transmit classified information.

Two aspects of the security problem are of concern. The first is protecting the information being transmitted. This is relatively straightforward, given the current technological feasibility of data encoders. These devices can be placed at each end of the transmission medium to encrypt/decrypt all information being transmitted.

The second, more difficult aspect is the operational security, or emissions control, which allows for covert operations. A data communications link should help reduce emissions by replacing lengthy voice messages with "bursty" data. Digital Selective Calling provides a ship's position message which takes .35 seconds to transmit, at 1200 bits per second [Ref. 16: p. 2]. Data rates of up to 100,000 bits per second, or 50,000 per half second, are achievable in the VHF radio band [Ref. 17: p. 48].

C. SYSTEM ARCHITECTURE

A capable ship-to-shore link will not enhance the operational mission unless the ashore network is configured to support the mission as well. Factors of concern include network capability, speed, reliability, and capacity to grow.

Most respondents envisioned a centralized database, where operational information could be stored and retrieved, in real time, by operational units underway. Respondents differed in where they thought this centralized database would be. Some visualized one large repository for the entire service, such as the current SEER database. Others saw more regionalized yet interconnected "subsystems" at the area, district, or group level.

Shipboard operations require timely receipt of information. Most respondents stated that receiving answers to queries within five minutes would be adequate for them to conduct their mission, although some allowed as much as fifteen minutes. Delays in this range are certainly attainable with current technology, provided the network is configured to bound the upper limit of delay [Ref. 17: pp. 286-305].

The ashore network must be robust enough to provide alternative routing around congestion. There is no need to maintain an exclusive "Coast Guard owned" network. Rather, the network could be composed of parts of owned, leased, and public data networks. The important point to the respondents is that they can be reasonably sure that a request will be answered in a timely manner.

Another critical issue is that of network access points. Currently, there are no terrestrial radio nodes used by the Coast Guard to connect a ship to a shoreside data network. There is interest in exploring this avenue during overhauls of present systems [Ref. 18]. A "fully connected" network would provide the capability to link into a shoreside network via HF, VHF, and UHF radio, although a less complete arrangement would still enhance operations. Figure 7 illustrates this concept.

As discussed in Chapter II, the Coastal patrol boat is being designed for flexibility. This logically leads to industry standard communications interfaces, such as those developed by International Standards Organization, International Consultative Committee on Telegraphy and Telephony, and others. Implementing these standards from the beginning will allow the vessel to quickly incorporate new advances in technology. The U. S. Government Open Systems Interconnection Profile provides a structure for combining these various protocols into an architecture that is standardized yet flexible [Ref. 19: pp. 288-290]. In addition, the evolving standards for interoperability between the mobile systems and the public switched networks should be monitored and adopted as they become established [Ref. 20].

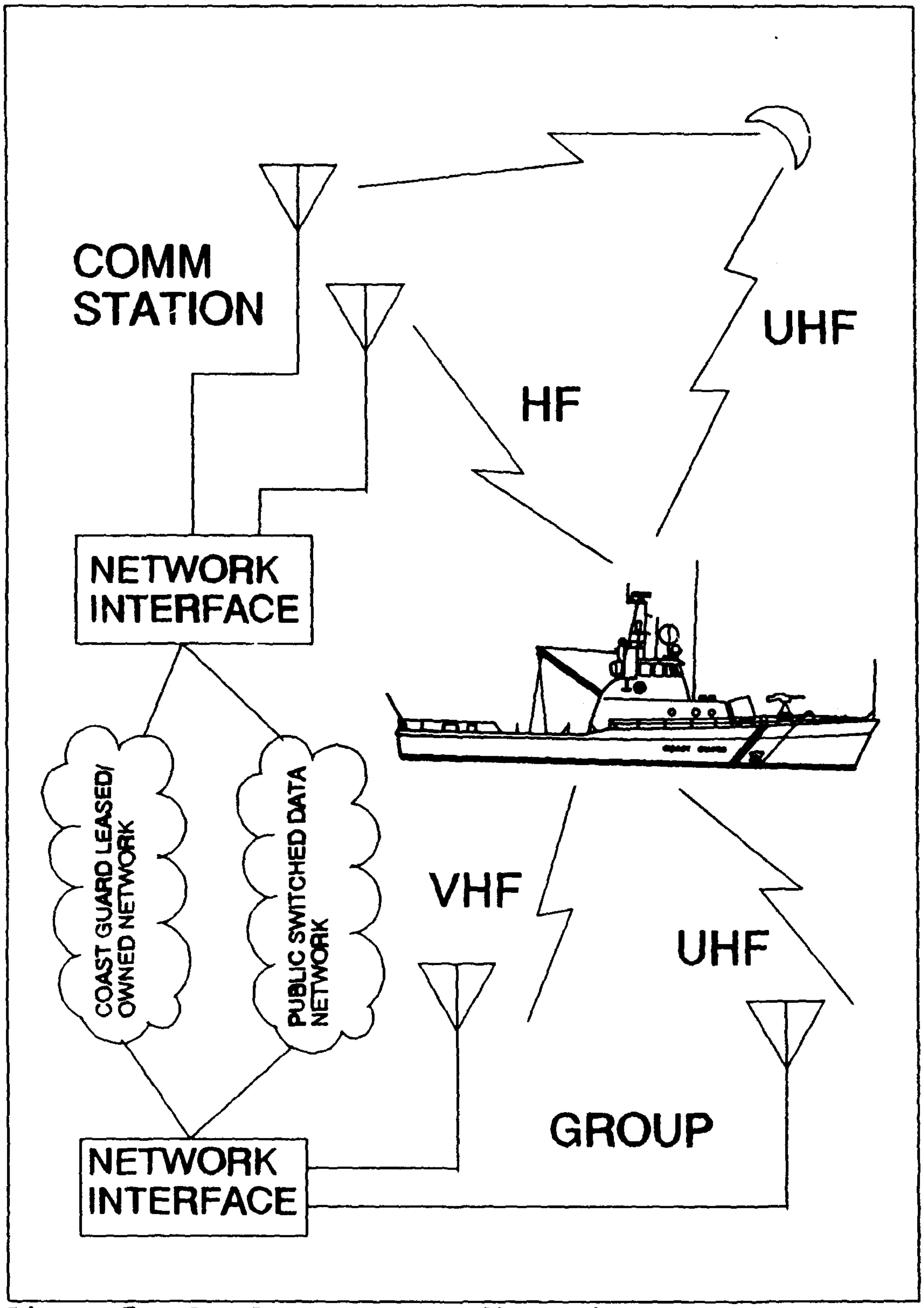

Figure 7: Sample Network Configuration

VII. CONCLUSIONS AND RECOMMENDATIONS

A. CONCLUSIONS

From the data presented in chapters V and VI, several groupings of patrol boat data needs emerge. These tiers of service are presented below, along with their justification.

1. Tier One - Essential Services

Access to law enforcement intelligence and vessel information is clearly the most desired feature cited by respondents. This result reflects the most common mission these boats routinely perform. The tools they need to professionally execute this mission are not available to them, namely the historical information collected about the vessel, its occupants and the activities of other enforcement resources. The present system of voice radio relay to telephone relay and manual searches of paper records certainly does not support the boarding decisions these units must make during every patrol. The services which will be available from the LEIS II database should not be denied to the Coastal Patrol Boat simply due to its length. In addition, current technologies, such as optical storage, can allow the patrol boat to carry static data like vessel documentation or registration information. The boat's primary mission is law enforcement and it should be afforded all of the tools reasonably available that facilitate the safe and successful execution of that mission.

An automated vessel position reporting capability needs to be incorporated into the vessel design. The system should be automated to reduce the amount of time the crew must devote to the system. The concerns raised about the autonomy of the skipper and crew are not disregarded lightly. However, providing a technological capability does not imply how it should be used. Those operational commanders who will micromanage their units will do so even if there is no vessel position reporting system; others will respect the boats' command authority even with a system. A vessel position reporting system can greatly benefit the responsiveness of the operational commander in making mission decisions while at the same time reducing the need for the patrol boat to transmit routine data via voice radio. The advantage of immediate feedback of search execution greatly outweighs the perceived loss of operating autonomy.

Receiving data from other sensor platforms, such as patrolling aircraft, is an essential part of conducting law enforcement and search and rescue. The whole purpose of having aircraft out patrolling in the first place is to make the surface boarding platforms (i.e., the patrol boat) more effective.

Some kind of command and control message capability must be provided. The traditional "Coast Guard message" is not necessarily required; what is required is a capability for the operational commander to pass to his patrol boat tasking instructions by some means other than voice radio. The reasons are threefold. First, voice radio is labor-intensive, requiring the full attention of both sender and receiver. Second, hand-copying radio messages is error-prone. Third, voice radio is time consuming, taking an inordinate amount of time to transmit and receive a remarkably small amount of data.

Finally, the capability to remotely monitor damage control and other on board sensors, such as intrusion alarms, should be incorporated. This ability to monitor the patrol boat's integrity from a distance will provide the skipper with additional flexibility in structuring his watch sections. This capability will not necessarily replace the in port watch; it will allow the ship to be monitored from the shoreside office spaces or other work areas. Detailed policy regarding the actual use of this capability will be left to the individual command and its operational commander.

2. Tier Two - Beneficial Services

An automated report generator would be extremely valuable to a patrol boat. Such a system would collect various data elements from an on board database, consolidate them into the required format and transmit the combination to the appropriate central database ashore. Ideally, this capability would be available to the vessel both underway and in port. This would provide the most timely information to operational commanders and other operational units alike. However, even a strictly in port system would greatly enhance the patrol boat's ability to report its operations in an expedient fashion.

Automated weather data will not provide a complete picture of the patrol boat's operating conditions. However, it can furnish some basic parameters which must be passed anyway for a given evolution, such as a search or tow. Automating the process will enable the persons on the boat to concentrate on collecting other data which cannot be automated. It will provide another tool for the operational commander to use in evaluating the tasking of his units.

Finally, current weather map data could substantially augment the patrol boat's ability to plan underway operations in the immediate future. Crew fatigue is one of the most limiting factors on patrol boat operations. Any means which can forewarn the crew of impending weather changes will contribute to vessel and crew safety.

3. Tier Three - Additional Services

Access to a centralized repository of current Coast Guard policy and procedures, at a group, for example, would be very helpful to a patrol boat underway. There are a multitude of special circumstances which occur infrequently but which require precise procedures that must be followed. By maintaining these policies and procedures at the group level, all group patrol boats will be applying the same guidelines. This capability will also reduce the amount of file maintenance that must be performed at the unit level.

Search planning decision aids are rarely used by the patrol boats, especially when underway. Providing access to decision tools located at a group will reduce the amount of extra programs which the patrol boat must maintain on its own system with no loss of functionality.

Digitized pictures of vessels and people could be a helpful tool in verifying their identity. However, with the data described as essential above, pictures would play only a supporting role.

Likewise, digital representations of vessel and seaman's documents would be helpful but not necessary. Any discrepancies found in the course of a boarding would not likely be resolved on scene but rather by the issuing Marine Inspection Office ashore.

Table III summarizes these conclusions.

Table III: SUMMARY OF CONCLUSIONS

Telecommunications Services	Concluded Importance Categories of Services
Law Enforcement Intelligence: Registration/Documentation Recent Boardings/Violations	TIER 1
Digital Pictures/Facsimile	TIER 3
Vessel Position & Track Data	TIER 1
Ship/Aircraft Data Sharing	TIER 1
Ship/Ship Data Sharing	TIER 1
Decision Checklists	TIER 3
Search Planning Aids	TIER 3
Policy & Procedure Aids	TIER 3
Weather Reporting	TIER 2
Weather Map Reception	TIER 2
Command & Control Messages	TIER 1
Damage Control/Sensor Data	TIER 1
Automated Report Generation	TIER 2
Layered Response Times	TIER 1
Value-added Data	TIER 1

B. AREAS FOR FURTHER STUDY

The whole area of group infrastructure needs to be addressed. A well-equipped and capable patrol boat will be a wasted resource if the group is not able to integrate the boat's operational data into the rest of the Coast Guard. Specific attention must be paid to the shoreside data network question as well as the access points and means available to underway units.

The Coast Guard as an organization needs to reconsider how it views information. After-action reporting is really unnecessary if the same information can be captured and reported in real time. Much of the current operational reporting is redundant and does not contribute to the on-going operations of other units.

The present deliberations of the Telecommunications Standards Committee (T1) of the Exchange Carriers Standards Association should be followed closely. The committees work will establish standard protocols for the interface between the land and satellite mobile systems and the public switched networks. These standards will have a profound affect upon the services that are available to ships and aircraft. [Ref. 20]

APPENDIX A

COAST GUARD MAJOR PROGRAMS

A. ENFORCEMENT OF LAWS AND TREATIES

The objectives of this program are [Ref. 21: p. 17]:

- Enforce federal law on the high seas and in U. S. waters.
- Interdict drug smugglers and illegal migrants.
- Enforce Exclusive Economic Zone laws and regulations up to 200 nautical miles off our shores.
- Inspect domestic and foreign fishing vessels.
- Help other agencies enforce our nation's laws.

This program consumes 34.7% of the Coast Guard's operating expense budget (Fiscal Year 1991) [Ref. 22: p. 10].

B. MARINE SAFETY

This program consists of two major activities: Commercial Vessel Safety and Recreational Boating Safety. The objectives of this program are [Ref. 21:p. 17]:

Commercial Vessel Safety

- Minimize deaths, injuries, property loss and environmental damage by developing and enforcing Federal standards for vessels, off-shore facilities, merchant marine personnel and other facilities engaged in commercial or scientific activity in the marine environment.

Recreational Boating Safety

- Reduce number of deaths, injuries and property damage caused by recreational boats.
- Improve boating safety.
- Encourage development, use and enjoyment of all U. S. waters.

This program consumes 6.4% of the Coast Guard's operating expense budget (FY-91) [Ref. 22:p. 16].

C. AIDS TO NAVIGATION

The objectives of this program are [Ref. 21:p. 18]:

- To develop, establish, maintain and operate audible, visible and radar aids to navigation to help navigators determine their position or safe course and warn of obstructions in or adjacent to navigable waters.
- Establish, operate and maintain electronic aids throughout the United States and in other areas of the world to provide continuous, accurate, all-weather positioning capability for military and civilian mariners and aviators.

This program consumes 20.2% of the Coast Guard's operating expense budget (FY-1991) [Ref. 22:p. 14].

D. ICE OPERATIONS

This program includes both domestic and polar ice operations. The objectives of this program are [Ref. 21:p. 18]:

- Provide icebreaking capability to support our national interests in Polar regions.

- Facilitate U.S. Maritime transportation through ice-laden domestic waters.
- Conduct International Ice Patrol which was initiated in 1912 after the Titanic struck an iceberg and sank.
- To observe and chart the positions and movement of icebergs.

This programs consumes 4.3% of the Coast Guard's operating expense budget (FY-1991) [Ref. 22:p. 12].

E. DEFENSE READINESS

The objective of this program is [Ref. 21:p. 19]:

- To provide constant Coast Guard military capability and readiness.

This program consumes 5.1% of the Coast Guard's operating expense budget (FY-1991) [Ref. 22:p. 18].

F. SEARCH AND RESCUE

The objectives of this program are [Ref. 21:p. 19]:

- To minimize loss of life, personal injury and property damage on the high seas.
- The U. S. Coast Guard keeps a nationwide system of boats, aircraft, cutters and rescue coordinations centers on 24-hour alert, ready to respond to a vessel in distress.

This program consumes 21.1% of the Coast Guard's operating expense budget (FY-1991) [Ref. 22:p. 6].

G. MARINE ENVIRONMENTAL PROTECTION

This program consists of two major activities: Marine Environmental Response and Port Safety and Security. The objectives of this program are [Ref. 21:p. 20]:

Marine Environmental Response

- Minimize damage caused by pollution released in the coastal zone.
- Overcome or reduce threat to the marine environment posed by potential spills of oil or hazardous substances.
- Assist in national and international pollution response planning.
- Cost recovery is the final stage of environmental response. Every effort is made to recover costs following a federal response.

Port Safety and Security

- Safeguard the nation's ports, waterways, waterfront facilities, vessels, personnel and property from accidental or intentional damage, disruption, destruction or injury.
- Monitor oil transfer and hazardous cargo operations to prevent spills.
- Conduct harbor patrols to detect oil or chemical spills.
- Enforce pollution regulations.

This program consumes 8.1% of the Coast Guard's operating expense budget (FY-1991) [Ref. 22:p. 8].

APPENDIX B

COMMAND AND CONTROL ORGANIZATION

Most patrol boats report directly to a Group command, both operationally and administratively. The patrol boat skipper is usually an O-2 or E-9. The patrol boat skipper is responsible to the Group Commander for all aspects of vessel operation and administration. Figure 8 illustrates this relationship.

A Group is an intermediate level command responsible for a given geographical area. Group boundaries usually extend about 50 nautical miles offshore. A Group typically exercises control over a number of operational units, such as patrol boats and small boat stations. It provides operational direction in both a general sense and for specific incidents. A Group is typically commanded by an O-4 to an O-6, depending on the size of the area. A Group Commander may direct units under his command to perform specific missions or he may receive tasking from the District Commander, the next higher level of command. Refer to Figure 8 to see this relationship. Usually, the Group controls its own resources. However, during large or particularly sensitive operations, the District may exercise operational control. In those cases, the Group merely acts as a conduit for information to and from the underway units.

A District is also responsible for operations within a given geographical area, usually several states and the adjacent ocean area 1200 to 1500 nautical miles offshore. A District Commander will usually control an operation when it involves resources from

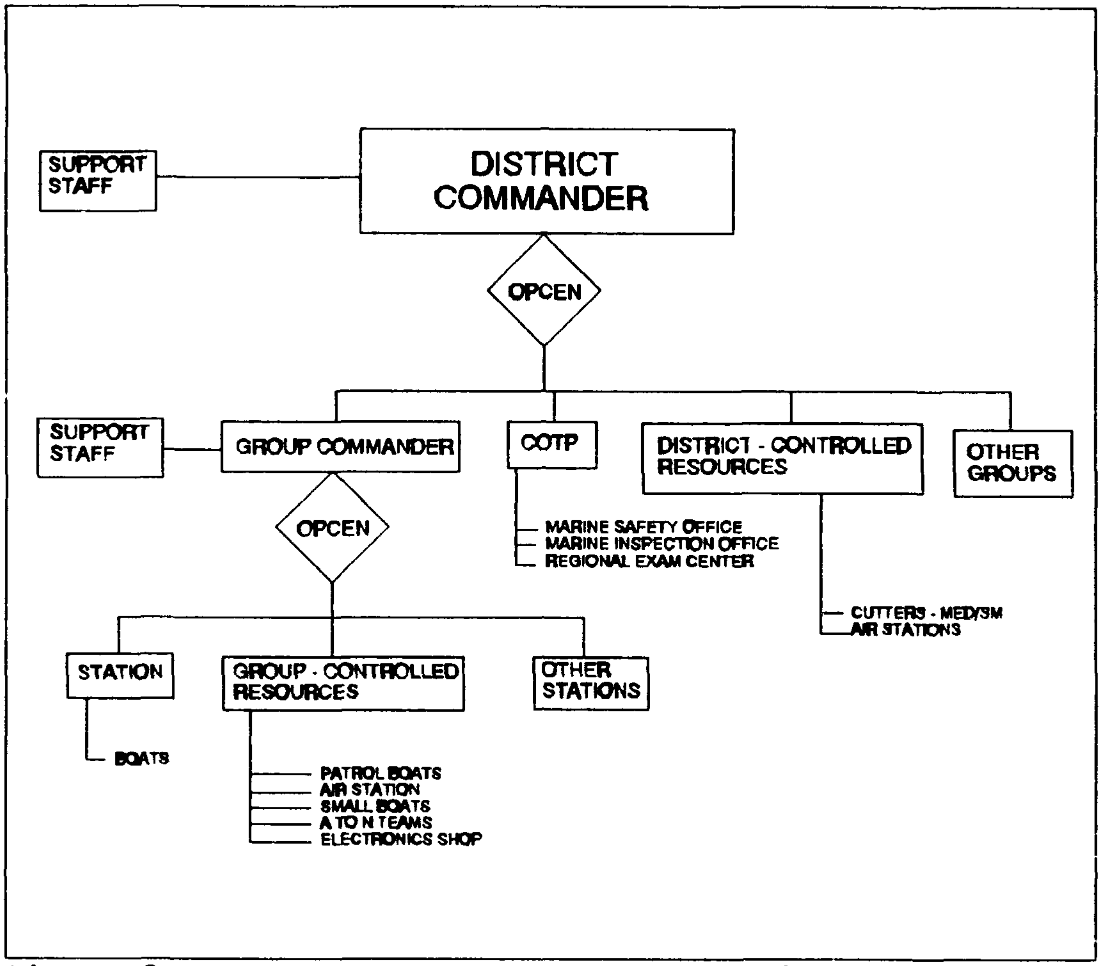

Figure 8: Command and Control Organization

more than one Group, resources from other services, multi-day searches, etc. Some Districts may control patrol boats while they are in a routine patrol status.

In addition, some mission areas, most notably port safety and security, are conducted under the statutory authority of a Captain of the Port (COTP). In many cases, the COTP is also the Group Commander. However, there are many places where the COTP area of responsibility overlaps that of a different Group Commander. In those cases, a patrol boat working under the control of a COTP will again use the Group as a conduit for information transfer.

APPENDIX C

PANEL MEMBERS

A. PATROL BOAT SKIPPERS

LT L. H. BENEDICT
Commanding Officer, USCGC POINT BROWER

LT J. S. LEE
Commanding Officer, USCGC POINT STUART
Commanding Officer, USCGC CAPE CROSS

LT P. S. MARSH
Commanding Officer, USCGC POINT LEDGE

LT S. M. NEILL
Commanding Officer, USCGC POINT JUDITH
Commanding Officer, USCGC RED BIRCH

BMCM D. W. THAUTE
Officer In Charge, USCGC POINT HANNON
Officer In Charge, USCGC POINT HOBART

LTJG J. E. VORBACH
Commanding Officer, USCGC POINT STUART

LT W. J. ZEIGLER
Commanding Officer, USCGC POINT BARROW
Commanding Officer, USCGC LONG ISLAND

B. OPERATIONS ASHORE

LT J. S. LEE
Controller, Fourteenth Coast Guard District Operations Center

LT P. S. MARSH
Controller, Thirteenth Coast Guard District Operations Center

CWO J. R. MAXSON
Operations Officer, USCG Group Monterey

LT S. M. NEILL
Operations Officer, USCG Group Honolulu

LCDR R. A. BUDDENBURG
Group Coordinator, USCG Group North Bend

C. DATABASE MANAGERS

LT D. R. Lincoln
U. S. Coast Guard Headquarters (G-TIS-2)

LCDR D. B. McLeish
U. S. Coast Guard Headquarters (G-TIS-2)

D. PROGRAM MANAGERS

LT S. J. Andersen
U. S. Coast Guard Headquarters (G-OCU)

LT W. M. Randall
U. S. Coast Guard Headquarters (G-TES-1)

INTERVIEW LIST

Andersen, S. J. to Stock, C. A., U. S. Coast Guard. Electronic Mail Note. May 24, 1991.

Andersen, S. J., U. S. Coast Guard. Telephone conversation with the author. May 28, 1991.

Andersen, S. J., to Stock, C. A., U. S. Coast Guard. Electronic Mail Note. May 31, 1991.

Benedict, L. H., LT, U. S. Coast Guard. Telephone conversation with the author. Apr. 4, 1991.

Benedict, L. H., to Stock, C. A., U. S. Coast Guard. Electronic Mail Note. June 3, 1991.

Buddenberg, R. A. to Stock, C. A., U. S. Coast Guard. Electronic Mail Note. Jan. 16, 1991.

Buddenberg, R. A. to Stock, C. A., U. S. Coast Guard. Electronic Mail Note. Mar. 1, 1991.

Buddenberg, R. A. to Stock, C. A., U. S. Coast Guard. Electronic Mail Note. Mar. 5, 1991.

Buddenberg, R. A. to Stock, C. A., U. S. Coast Guard. Electronic Mail Note. Mar. 6, 1991.

Buddenberg, R. A. to Stock, C. A., U. S. Coast Guard. Electronic Mail Note. Apr. 3, 1991.

Buddenberg, R. A. to Stock, C. A., U. S. Coast Guard. Electronic Mail Note. Apr. 5, 1991.

Lee, J. S., LT, U. S. Coast Guard. Telephone conversation with the author. Apr. 29, 1991.

Lincoln, D. R. to Stock, C. A., U. S. Coast Guard. Electronic Mail Note. Mar. 5, 1991.

Lincoln, D. R. to Stock, C. A., U. S. Coast Guard. Electronic Mail Note. Mar. 15, 1991.

Lincoln, D. R. to Stock, C. A., U. S. Coast Guard. Electronic Mail Note. Mar. 18, 1991.

Lincoln, D. R. to Stock, C. A., U. S. Coast Guard. Electronic Mail Note. Mar. 19, 1991.

Lincoln, D. R. to Stock, C. A., U. S. Coast Guard. Electronic Mail Note. Mar. 22, 1991.

Lincoln, D. R. to Stock, C. A., U. S. Coast Guard. Electronic Mail Note. Apr. 13, 1991.

Marsh, P. S., LT, U. S. Coast Guard. Personal interview with the author. Mar. 5, 1991.

Marsh, P. S., LT, U. S. Coast Guard. Personal interview with the author. Apr. 30, 1991.

Maxson, J. R., CWO, U. S. Coast Guard. Personal interview with the author. May 29, 1991.

Neill, S. M., LT, U. S. Coast Guard. Telelphone conversation with the author. May 21, 1991.

Neill, S. M., LT, U. S. Coast Guard. Telephone conversation with the author. May 23, 1991.

Randall, W. M. to Stock, C. A., U. S. Coast Guard. Electronic Mail Note. Jan. 18, 1991.

Randall, W. M. to Stock, C. A., U. S. Coast Guard. Electronic Mail Note. Mar. 5, 1991.

Randall, W. M. to Stock, C. A., U. S. Coast Guard. Electronic Mail Note. Apr. 5, 1991.

Stock, C. A. to Randall, W. M., U. S. Coast Guard. Electonic Mail Note. Feb. 27, 1991.

Stock, C. A. to McLeish, D. B., U. S. Coast Guard. Electronic Mail Note. Feb. 28, 1991.

Stock, C. A. to Lincoln, D. R., U. S. Coast Guard. Electronic Mail Note. Mar. 12, 1991.

Stock, C. A. to McLeish, D. B., U. S. Coast Guard. Electronic Mail Note. Mar. 13, 1991.

Stock, C. A. to Buddenberg, R. A., U. S. Coast Guard. Electronic Mail Note. Apr. 4, 1991.

Stock, C. A. to Randall, W. M., U. S. Coast Guard. Electronic Mail Note. Apr. 4, 1991.

Stock, C. A. to Benedict, L. H., U. S. Coast Guard. Electronic Mail Note. Apr. 11, 1991.

Stock, C. A. to Lincoln, D. R., U. S. Coast Guard. Electronic Mail Note. Apr. 12, 1991.

Stock, C. A. to Andersen, S. J., U. S. Coast Guard. Electronic Mail Note. Apr. 25, 1991.

Thaute, D. D., BMCM, U. S. Coast Guard. Telephone conversation with the author. Apr. 30, 1991.

Vorbach, J. E., LTJG, U. S. Coast Guard. Telephone conversation with the author. May 9, 1991.

Vorbach, J. E., LTJG, U. S. Coast Guard. Telephone conversation with the author. May 13, 1991.

Ziegler, W. J., LT, U. S. Coast Guard. Personal interview with the author. Apr. 10, 1991.

LIST OF REFERENCES

1. Randall, W. M. to Stock, C. A., U. S. Coast Guard. Electronic Mail Note. Jan. 18, 1991.

2. U. S. Department of Transportation. U. S. Coast Guard. "Sponsor's Requirement Document, Coastal Patrol Boat, of the Patrol Boat Acquisition Program," April 1991.

3. Levenbach, Hans, and Cleary, James P. *The Modern Forecaster: The Forecasting Process Through Data Analysis*. Belmont, CA: Lifetime Learning Publications, 1984.

4. Johnson, Robert E. *Guardians of the Sea: History of the United States Coast Guard 1915 to the Present*. Annapolis: Naval Institute Press, 1987.

5. U. S. Department of Transportation. U. S. Coast Guard. *Organization Manual for Patrol Boat (82') (WPB)*. CG-260-6, 1976.

6. Bronfenbrenner, Martin; Sichel, Werner; and Gardner, Wayland. *Microeconomics*. 3rd ed. Boston: Houghton Mifflin Company, 1990.

7. Peterson, Willis L. *Introduction to Economics*. Englewood Cliffs, NJ: Prentice-Hall, 1977.

8. Maurice, S. Charles and Smithson, Charles W. *Managerial Economics: Applied Microeconomics for Decision Making*. 3rd ed. Homewood, IL: Richard D. Irwin, 1988.

9. Granger, C. W. J. *Forecasting in Business and Economics*. New York: Academic Press, 1980.

10. Commanding Officer, U. S. Coast Guard Operations Computer Center to Commandant, U. S. Coast Guard (G-OLE-1). 16249, March 6, 1991.

11. Series of electronic mail, telephone and personal interviews conducted by the author between January 16 and June 3, 1991. Complete reference to these interviews found in Appendix C.

12. Jones, Wendell O. "The Determination of Future User Requirements for an Existing Management Information System using a Delphic Methodology." Ph.D. dissertation, University of Georgia, 1978.

13. Fischer, Dell and Gupta, Ramesh. "Taking a Second Look at Video Conferencing." *Data Communications* 19 (June 1990): 111-118.

14. U. S. Department of Transportation. U. S. Coast Guard. *System Specification for the Law Enforcement Information System II (LEIS II).* Rev. 0.0. Document Control Number LEIS-4007, by Systems Resources Corporation, July 1990.

15. Marsh, Peter S. "U. S. Coast Guard Operational Information Systems: Improving functionality and Cross-functionality." Master's thesis, Naval Postgraduate School, 1991.

16. International Consultative Committee for Radio. "Digital Selective-Calling System for use in the Maritime Mobile Service, Recommendation 493-3 (MOD F)." CCIR Document 8/1037-E, December 1989.

17. Stallings, William. *Data and Computer Communications.* 2nd ed. New York: Macmillan Publishing, 1988.

18. Glidden, William C. "The U. S. Coast Guard's VHF-FM National Distress System: Analysis for Recapitalization." Master's thesis, Naval Postgraduate School, 1991.

19. Black, Uyless. *Data Networks: Concepts, Theory, and Practice.* Englewood Cliffs, NJ: Prentice-Hall, 1989.

20. Exchange Carriers Standards Association. Standards Committee T1 Telecommunications. "Interoperability Between the Land and Satellite Mobile Systems (Land, Marine and Aeronautical) and the Public Switched Telephone, Data and Packet Switched Networks, Including ISDN." Project Proposal T1AG/90-039, March, 1990.

21. U. S. Department of Transportation. U. S. Coast Guard. "Coast Guard: 200 Years of Service." *Commandant's Bulletin*, no. 9 (1989), pp. 1-24 (pull-out section).

22. U. S. Department of Transportation. U. S. Coast Guard. "U. S. Coast Guard Budget in Brief: FY 1992." *Commandant's Bulletin*, no. 3 (1991), pp. 1-22 (pull-out section).

INITIAL DISTRIBUTION LIST

1.	Defense Technical Information Center Cameron Station Alexandria, Virginia 22304-6145	2
2.	Library, code 0142 Naval Postgraduate School Monterey, CA 93943-5002	2
3.	Chairman, code AS Naval Postgraduate School Monterey, CA 93943-5000	1
4.	Prof. W. Gates, Code AS/Gt Naval Postgraduate School Monterey, CA 93943-5000	1
5.	Prof. M. Suh, Code AS/Su Naval Postgraduate School Monterey, CA 93943-5000	1
6.	Prof. D. Boger, Code AS/Bo Naval Postgraduate School Monterey, CA 93943-5000	1
7.	Commandant (G-TPP) U. S. Coast Guard Washington, DC 20593-0001	2
8.	LT W. Zeigler USCGC Long Island 100 Lighthouse Ave. Monterey, CA 93940	1
9.	LT L. Benedict U. S. Coast Guard Training Team One Coast Guard Island Alameda, CA 94501-5100	1

10. LT D. Lincoln 1
Commandant (G-TIS-2)
U. S. Coast Guard
Washington, DC 20593-0001

11. LT C. Stock 2
Eleventh Coast Guard District (dttm)
400 Oceangate
Long Beach, CA 90822